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PID CONTROLLER OPTIMIZED BY GREY WOLF OPTIMIZER FOR SEMI-ACTIVE VEHICLE SUSPENSION SYSTEM

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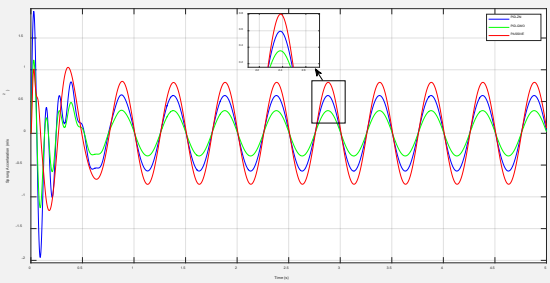
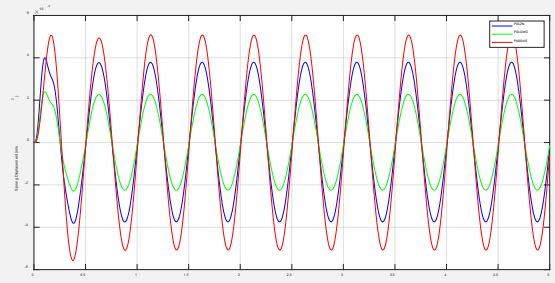
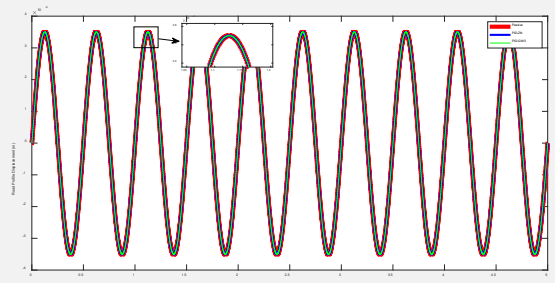


Sprung acceleration for sinusoidal disturbances



Sprung displacement for sinusoidal disturbances



Road profile for sinusoidal disturbance

Modern automobiles have evolved from leaf and coil suspension in 1904 to electronic suspension in the 1980s, where the suspension system provides the user with easy control of the vehicle and makes the driver and passenger comfortable with the impact of particular road conditions. Control suspension systems have been extensively researched using smart artefacts to improve ride comfort and road holding. Suspension systems come in three types: passive, active, and semi-active. The semi-active suspension combines the benefits of both passive and active suspension for enhanced comfort, safety, and energy efficiency. Various controllers have been introduced, but the PID controller is the most common control algorithm used and has been universally applied in many industrial applications.

The PID controller is favoured due to its affordability, simplicity in control structure and ease of maintenance. However, the drawback of this controller is finding the right parameter values, which is time-consuming to achieve the system's optimal performance. Therefore, the grey wolf optimizer (GWO) is proposed to enhance the controller performance. GWO is a popular optimization algorithm that mimics grey wolfs' social structure and hunting tactics. This research investigates the advantages of this novel optimization algorithm in improving vehicle suspension systems.

In this study, the quarter semi-active suspension system with a Magneto-Rheological (MR) damper is developed in a MATLAB/Simulink environment. The semi-active damper model is designed using the Spencer model and used to incorporate it with the MR damper system. A Proportional-Integral-Derivative (PID) controller is fine-tuned using the grey wolf optimization (PID-GWO) algorithm and compared its performance against a PID controller tuned by Ziegler-Nichols (PID-ZN) approach. The system is subjected to both sinusoidal and random disturbances in order to test the robustness of the system.

Ultimately, the proposed PID-GWO controller showed the highest percentage improvement in sprung acceleration, sprung displacement, and unsprung acceleration in both disturbances. In contrast, the PID-ZN controller showed the lowest percentage improvement in these areas. This study provides valuable insights into reducing vibrations in the semi-active suspension system. The results demonstrate the effectiveness of the PID-GWO controller in reducing vibrations in the semi-active suspension system.

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